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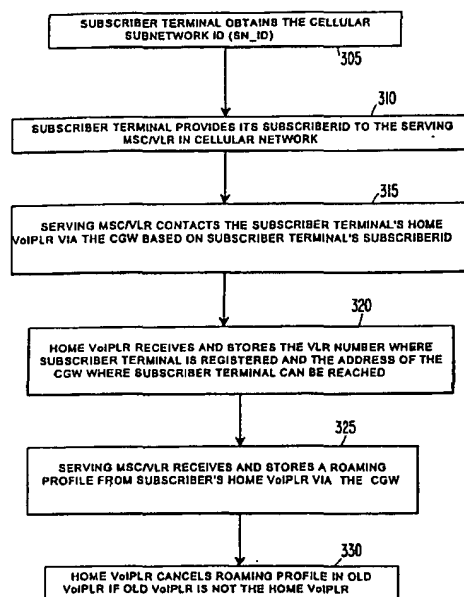
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- (71) Applicant (*for all designated States except US*): **NOKIA NETWORKS OY** [FI/FI]; Nokia Group, P.O. Box 300, FIN-00045 Nokia Group (FI).
- (72) Inventors; and
- (75) Inventors/Applicants (*for US only*): **FACCIN, Stefano**, (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European

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(54) Title: **MOBILITY BETWEEN IP TELEPHONY NETWORKS AND CELLULAR NETWORKS**



(57) Abstract: A technique is provided allowing a subscriber to roam between two types of networks, including a packet-switched telephony network (or IP-telephony network) and a cellular network. As an example, a subscriber terminal that is a subscriber of a first type of network includes a Home location register in the first type of network, and roams to a second type of network. The Home location register may be a Home VoIPLR for a IP-telephony network subscriber, or a HLR for a cellular network subscriber. To register in the new or second type of network, the subscriber terminal provides a subscriber ID to a serving location register located in the second type of network. The serving location register in the second type of network then sends updated location information for the subscriber to the subscriber's home location register located

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in first type of network via a gateway based on the subscriber ID. The gateway (e.g., a cellular gateway) interfaces the first and second types of networks. A call request to the subscriber terminal is received. The subscriber's updated location information is obtained from the Home location register and is used to establish the call to the subscriber.

MOBILITY BETWEEN IP TELEPHONY NETWORKS AND CELLULAR NETWORKS

Technical Field

This application generally relates to packet-switched telephony networks, such as IP telephony networks, and to cellular networks, and more particularly to a technique that allows subscribers to roam between an IP-telephony network and a cellular network.

IP-Telephony Networks

Voice or telephony services can now be provided over a packet-switched network, such as the Internet. These packet-switched -telephony networks are commonly referred to as IP telephony networks because the Internet Protocol (IP) is the primary protocol used over the Internet. One IP telephony standard, for example, is the International Telecommunications Union (ITU) H.323 standard.

Fig. 1 illustrates an example of an IP telephony network, also known as a Voice over IP (VoIP) Network. The VoIP network includes a gatekeeper function, one or more gateways and a packet-switched network (e.g., a portion of the Internet).

The gatekeeper function is optional and provides call authorization for both accepting and placing calls in its zone or area of control. A gatekeeper can also allocate bandwidth, can maintain call detail records, and can perform other network management functions.

A packet-switched- telephony gateway bridges a circuit switched network such as the Public Switched Telephone Network (PSTN) and a packet-switched network such as an IP network or the Internet. The IP telephony gateway bridges the PSTN and IP networks to allow phone-to-phone and phone-to-personal computer (PC) multimedia communications (voice, video and/or data). The IP telephony gateway provides the appropriate translation between transmission formats (for example, H.225.0 of an H.323 endpoint to/from H.221 of an H.320 endpoint) and between communication procedures (for example, H.245 of an H.323 endpoint to/from H.242 of an H.320 endpoint). The IP telephony gateway also performs call setup and clearing on both the network side and the switched circuit network side. Translation between video, audio, and data formats may also be performed in the gateway. In general, the purpose of the IP-telephony gateway is to complete the call in both directions between the network endpoint and the switched circuit network endpoint in a transparent fashion.

An example of IP telephony gateway is the H.323 gateway (implementing the ITU H.323 standard). H.323 gateways allow interoperation of H.323 systems with other audio/video conferencing systems on Integrated Services Digital Networks (ISDN), plain old telephone systems (POTS), Asynchronous Transfer Mode (ATM), and other transports.

An IP telephony gateway operates as an endpoint on the IP-telephony network that provides real-time, two-way communication between IP telephony terminals on the IP-based network and other ITU terminals on a switched-circuit network, or to another IP-telephony gateway. Switched

Circuit Network connectivity is achieved in the IP telephony context by using gateways for H.320 (ISDN), H.324, H.323, POTS, and other endpoints on other networks.

Fig. 1 is a diagram illustrating an example IP telephony network. Referring to Fig. 1, when an incoming call (1) reaches an IP telephony gateway (GW) (here indicated as Originating IP telephony GW), the gateway contacts the gatekeeper it is registered with asking to set up a call towards the dialed number received from the incoming call set up request (Access Request, ARQ, 2). The gatekeeper translates the dialed number (or directory number) into the IP address of the Destination IP-telephony gateway, i.e. the gateway that has to be reached in order to reach the final destination of the call, and provides this IP address to the originating IP telephony gateway (Access Confirmation, ACF, 3). The Originating IP-telephony GW sets up an IP-telephony call over the packet-switched network or IP network towards the Destination IP-Telephony GW providing its IP address and the dialed number (Call setup, 3). The Destination IP-telephony GW contacts the gatekeeper it is registered with (it may be the same as the Originating IP-telephony GW or a different gatekeeper) asking to accept a call incoming from the Originating IP-telephony GW (ARQ, 4) and directed towards the dialed number. If the gatekeeper grants the incoming call to the Destination IP-telephony GW (ACF, 5), the Destination IP-telephony GW establishes the PSTN call (call, 7), and then the call is established between the two IP-telephony GWs over the IP network (call establishment, 6). The destination IP-telephony gateway translates the IP packets into the appropriate format for transmission over the PSTN.

However, IP telephony standards and products are currently defined only for fixed networks. Mobility has not been considered in IP telephony in the sense that IP telephony subscribers are not allowed to roam between IP telephony networks.

For example, a subscriber in one area of the country is registered with a local gatekeeper.

5 If the subscriber moves or travels to another part of the country, the subscriber will not be able to connect to the gatekeeper in the new part of the country because the new gatekeeper has no information describing the subscriber.

Cellular Networks

10 In addition, cellular subscribers can roam within cellular communication systems. In Global System for Mobile (GSM), a visiting location register (VLR) and a home location register (HLR) are used. The VLR contains relevant data of all mobile stations currently located in a serving Mobile Services Switching Center (MSC). The HLR is a database in charge of the management of the mobile subscribers. The data stored in the HLR includes service subscription
15 information and location information (the identity of the currently serving VLR to enable routing of mobile-terminated calls).

When a visiting (or roaming) cellular subscriber is detected in a serving system, the location update processes notify the subscriber's HLR of the subscriber's presence in the serving system. When the subscriber is detected for the first time, the serving system creates a temporary
20 record for the subscriber storing the service information and the location information. When the subscriber changes serving areas, the record in the HLR is simply updated with the new location information. In both cases the HLR is notified. When the HLR is notified by the serving system,

it updates the location information in the subscriber's record. If the location information is different from the one previously stored in the record, the HLR cancels the subscriber's location in the previous serving system.

If subscriber B is roaming in a serving cellular system and a party A dials subscriber B's
5 directory number, the call is routed through the PSTN to the home system of subscriber B. The MSC in the home system that receives the incoming call contacts subscriber B's HLR to determine how to route the call. The HLR determines that the call is for subscriber B and issues a request to subscriber B's current serving system for the information to route the call. The serving system allocates a telephone number (often called Roaming Number or RN) temporarily
10 assigned to subscriber B to route the call and provides the RN to the HLR. The HLR provides the RN to the MSC in the home system, which in turn routes the call to the RN through PSTN. When the serving system receives the incoming call, it associates it with subscriber B based on the RN, and pages the subscriber B.

However, cellular networks and IP-telephony networks are distinct and incompatible
15 networks and do not allow for roaming between cellular and IP-telephony networks.

Therefore, a need exists for a technique that allows subscribers to roam between an IP telephony network and a cellular network.

Summary of the Invention

According to an embodiment of the present invention, a technique is provided to allow
20 roaming or mobility between a packet-switched telephony network (e.g., an IP-telephony network) and a cellular network. An IP-telephony network or a voice over IP (VoIP) network

having mobility or roaming capabilities referred to herein as a Mobile VoIP (MVoIP) network.

According to an embodiment of the present invention, a technique is provided that allows a subscriber to roam between two types of networks, including a packet-switched telephony network (or IP-telephony network) and a cellular network. As an example, a subscriber terminal that is a subscriber of a first type of network includes a Home location register in the first type of network, and roams to a second type of network. The Home location register may be a Home VoIPLR for a MVoIP network subscriber, or a HLR for a cellular network subscriber. To register, the subscriber terminal provides a subscriberID to a serving location register located in the second type of network. The serving location register in the second type of network sends a message to the subscriber's home location register located in the first type of network via a gateway based on the subscriberID. The gateway (e.g., a cellular gateway) interfaces the first and second types of networks. The subscriber's Home location register in the first type of network receives the message, including updated location information for the subscriber terminal. The Home location register stores the subscriber's updated location information. A call request to the subscriber terminal is received at the first type of network. The subscriber's updated location information is obtained from the Home register and is used to establish the call to the subscriber.

Thus, a technique is provided to allow internetwork roaming by updating the subscriber's location information stored in the subscriber's Home location register, regardless where the subscriber's Home location register is located. Because the registers or devices in the cellular network communicate using cellular network procedures and registers or devices in the MVoIP

network communicate using MVoIP network procedures which are incompatible, devices or registers in the two types of networks must communicate through a cellular gateway. The cellular gateway interfaces the cellular network and the MVoIP (or packet-switched telephony) network.

5 According to another example embodiment of the present invention, a technique is provided that allows a packet-switched telephony network subscriber to roam to a cellular network. A terminal of a packet-switched telephony network subscriber registers or provides the subscriber's subscriberID to a serving visiting location register (VLR) in the cellular network where the subscriber terminal is located. The VLR is identified by a register number, such as a
10 VLR number. A message is sent from the serving VLR to the subscriber's home location register (i.e., the subscriber's Home VoIPLR) in the packet-switched telephony network via a cellular gateway based on the subscriber's subscriberID. The subscriber's Home VoIPLR in the packet-switched telephony network receives the message. The received message includes the VLR number identifying the serving VLR in the cellular network where the subscriber terminal is
15 located and an address of the cellular gateway where the subscriber terminal can be reached. The address of the cellular gateway can be added to the message as the message passes through the cellular gateway.

 A request for a call to the subscriber and an alias corresponding to the subscriber are received (e.g., as a PSTN call) at the MVoIP network. The address of the cellular gateway where
20 the subscriber can be reached and the roaming number assigned to the subscriber terminal are obtained. A packet-switched telephony call is established to the cellular gateway, providing the subscriber's roaming number. A call is routed from the cellular gateway to the subscriber

terminal based on the subscriber's roaming number. A similar (or symmetric) set of procedures can be used to register and route calls for cellular subscribers that are roaming in a MVoIP network.

Brief Description of the Drawings

5 Fig. 1 is a diagram illustrating an example of an IP telephony network.

 Fig. 2 is a block diagram illustrating an example system architecture according to an embodiment of the present invention.

 Fig. 3 is a flow chart illustrating a registration procedure for a subscriber roaming to a cellular network according to an embodiment of the present invention.

10 Fig. 4 is a flow chart illustrating an example call delivery to a packet-switched telephony network subscriber roaming in a cellular network according to an embodiment of the present invention.

 Fig. 5 is a diagram illustrating an example call delivery for a PSTN call to a packet-switched telephony network subscriber that has roamed to a cellular network according to an embodiment of the present invention.

15 Fig. 6 is a diagram illustrating an example call delivery for a PSTN call to a cellular network subscriber that has roamed to a MVoIP network according to an embodiment of the present invention.

Best Mode For Carrying Out The Invention

Introduction

According to an embodiment of the present invention, a technique is disclosed to allow roaming between a VoIP network and a cellular network. As used herein, a VoIP network having mobility or roaming capabilities is referred to herein as a Mobile VoIP (MVoIP) network. A technique is described herein which supports roaming between a MVoIP network and a cellular network and for the routing of calls to mobile users or subscribers roaming between a MVoIP network and a cellular network.

According to an embodiment of the present invention, each user belonging to MVoIP network or a cellular network is identified by an alias. The alias can take many forms, so long as it identifies the user. The alias can be a Directory Number - DN (e.g., E.164 format) that can be dialed to set-up a call towards the user. The user can also be identified or associated with a Logical Name - LN.

Also, it is assumed that each user of a MVoIP network or a cellular network is either a subscriber of the MVoIP network or a subscriber of a cellular network (i.e., where the subscriber's home location register is located, either HLR or Home VoIPLR). Thus, users will be referred to hereinafter as subscribers. Each subscriber is associated with a globally unique identifier - a SubscriberID. The subscriber is associated with a profile, which may include information describing the subscriber including the subscriber's SubscriberID, the subscriber's directory number (DN) and, optionally, the Logical Name associated to the subscriber.

The SubscriberID is used by the subscriber to identify itself and by the serving location registers where the subscriber terminal is located (e.g., the VoIPLR in the MVoIP network and

the VLR in the cellular network) to contact the subscriber's home location register in order to retrieve the corresponding subscriber profile and provide updated location information for the subscriber. A subscriber is also associated with an IP address, which indicates the address where the subscriber terminal can be reached with respect to the MVoIP network. For example, the subscriber's IP address is seen as the transport address at which the subscriber can be reached on the packet-switched network (e.g., the subscriber's IP network address). The subscriber's IP address is the IP address where a mobile terminated IP-telephony call can be routed in the MVoIP network to reach the subscriber. The IP address at which the subscriber can be reached may be either the actual address of the subscriber or the address of a cellular gateway or a gatekeeper through which the subscriber can be reached.

The subscriber's IP address can be allocated both statically (i.e., the address is assigned by the MVoIP network at subscription time and, as such, stored in the subscriber profile) and/or dynamically (i.e., assigned when the subscriber connects to the MVoIP network and, optionally, changed at every time the subscriber reconnects; the address is stored in the subscriber profile every time the user reconnects). According to an embodiment of the present invention, the subscriber terminal can have a different (and temporary) IP address each time it connects to a new MVoIP network or subnetwork. For example, the new current IP address can be generated or obtained using IP address configuration protocols, such as Dynamic Host Configuration Protocol (DHCP), or other techniques.

As described below, when a subscriber is connected to a MVoIP network, its IP address (where it can be reached) can be the address of the subscriber terminal itself or the IP address of a control entity or gatekeeper in the MVoIP network. If the subscriber has roamed to a cellular

network, the subscriber's IP address can be the IP address of a cellular gateway (CGW), which provides an interface between the MVoIP network and the cellular network according to an embodiment of the present invention.

In order to support roaming or mobility in MVoIP networks and between an MVoIP
5 network and a cellular network, some functional elements or capabilities are provided according to an embodiment of the present invention. In an example embodiment of the present invention, the standard IP telephony network capabilities are augmented through the introduction of three functional elements: a VoIP Location Register (VoIPLR), a Mobile IP Telephony GW (MITGW), and a Cellular Gateway (CGW), each described in detail below.

10 As used herein, a subscriber may be a MVoIP (or IP-telephony) network subscriber, meaning that its Home location register is located in the MVoIP network (its Home VoIPLR). In such case, the MVoIP subscriber may roam to a cellular network. However, updated location information must be provided to the subscriber's Home VoIPLR to allow calls to be correctly routed to the subscriber, which is now located in the cellular network.

15 Alternatively, a subscriber may be a cellular network subscriber, meaning that its Home location register (i.e., its HLR) is located in the cellular network. When a cellular network subscriber roams to the MVoIP network, the subscriber's HLR in the cellular network must receive updated location information for the subscriber.

20 A subscriber may communicate using different types of terminals (e.g., fixed telephone, personal computer, cellular or wireless communication device, etc.), regardless whether the subscriber is a cellular subscriber or a MVoIP network subscriber. If a subscriber is a subscriber

of a particular network, this only indicates where he is homed, but does not limit the type of terminal the subscriber may use. For example, when a MVoIP network subscriber is roaming in the cellular network, the subscriber may use a cellular device for communicating with the cellular network.

5 **System Architecture**

Referring to the figures in which like numerals indicate like elements, Fig. 2 is a block diagram illustrating an example system architecture according to an embodiment of the present invention. An MVoIP network 202 includes one or more subnetworks, including, subnetwork 1 (subnet 1) 210 and subnetwork 2 (subnet 2) 230. Although two subnetworks are shown, any
10 number can be provided within a MVoIP network. Subnetwork 1 210 includes subnetwork area A 212 and subnetwork area B 214. Similarly, subnetwork 2 230 is divided into area A 232 and area B 234. An example subscriber terminal Y 222 is connected to subnetwork 1 210. Similarly, there may be any number of areas in each subnetwork.

Referring to Fig. 2, one or more gatekeepers are connected to each subnetwork. Each
15 gatekeeper operates as a control entity because it controls the establishment of IP telephony calls in a particular zone or area. Gatekeeper 1 (GK1) 216 is connected to area A 212 and gatekeeper 2 (GK2) 218 is connected to area B 214 of subnetwork 1 210. Also, Gatekeeper 3 (GK3) 236 is connected to area A 232 and gatekeeper 4 (GK4) 238 and gatekeeper 5 (GK5) 240 are connected to area B 234 of subnetwork 2 230. Each subnetwork may correspond to a portion of
20 a packet-switched network (e.g., a portion of the Internet, or a Local Area Network, a portion of a Wide Area Network, etc.).

According to an embodiment of the present invention, a VoIP Location Register

(VoIPLR) is connected to each subnetwork. VoIPLR 1 220 is connected to subnetwork 1 210 and VoIPLR 2 242 is connected to subnetwork 2 230. As described in detail below, each VoIPLR is a database that stores a record or profile on subscribers and allows the subscribers to roam between MVoIP networks and subnetworks and allows subscribers roam
5 between a MVoIP network and a cellular network.

In addition, according to an embodiment of the present invention, the subnetworks 210 and 230 are connected to the PSTN 250 via one or more Mobile IP telephony gateways (MITGWs). For example, as shown in Fig. 2, MITGW 1 260 is connected between PSTN 250 and subnetwork 1 210. Likewise, MITGW 2 262 and MITGW 3 264 are each connected
10 between the PSTN 250 and subnetwork 2 230. A terminal X 252 is connected to PSTN 250 and may or may not be a MVoIP network subscriber. The other terminals in Fig. 2, for this example, are assumed to be MVoIP network subscribers.

According to an embodiment of the present invention, each area may correspond to a gatekeeper zone described in H.323. As such, there may be one gatekeeper for controlling each
15 zone or area. Alternatively, there may be many gatekeepers associated with each area (e.g., each area includes many zones), or there may be one gatekeeper for many areas.

According to an embodiment of the present invention, there may be many MVoIP networks connected to one another. The present invention allows subscriber terminals to roam between MVoIP networks and between subnetworks (within one MVoIP network). In
20 addition, subscribers may roam between the MVoIP network 202 and a cellular network 270. Cellular network 270 includes a Mobile Services Switching Center (MSC) and a visiting location register (VLR), illustrated in Fig. 2 as MSC/VLR 280. The MSC coordinates the setting up of

calls to and from subscribers. The VLR contains relevant data of all mobile stations currently located in a serving MSC. Although the MSC and VLR are shown as being together in Fig. 2, the MSC and VLR may be separated. Cellular network 270 also includes a HLR 282. An example subscriber terminal Z 276 is coupled via a wireless link 278 to the MSC/VLR 280.

5 Cellular network 270 may include one or more additional components for coupling the subscriber terminal Z 276 to MSC/VLR 280, including a Base Transceiver Station and a Base Station Controller (not shown) as well understood by those skilled in the art. The particular network configuration shown in Fig. 2 is provided only as an example embodiment that is used to explain the concepts of the present invention. The present invention is not limited to the configuration
10 illustrated in Fig. 2.

Cellular network 270 can include one or more subnetworks, where each subnetwork includes a corresponding MSC/VLR. Thus, cellular network 270 would typically include many MSC/VLRs each corresponding to a different cellular subnetwork. Only one of the MSC/VLRs is shown in Fig. 2 for the sake of brevity.

15 **The Mobile Voice over IP Telephony Network Location Register (VoIPLR)**

Each subscriber of a MVoIP network is statically associated with (homed by) one VoIPLR at subscription time, referred to herein as the Home VoIPLR. Each VoIPLR is associated with a unique VoIPLR Identification (VoIPLR_ID). Each VoIPLR corresponds to a specific sub-network of the MVoIP network. (Alternatively, each VoIPLR could correspond to
20 a specific MVoIP network or area).

As described above regarding Fig. 2, each MVoIP sub-network can be divided into different areas. When the subscriber terminal connects to a MVoIP network (or subnetwork),

the MVoIP network identifies the particular MVoIP network, subnetwork or subnetwork area to which the subscriber terminal is connecting. According to an embodiment of the invention, each subscriber terminal receives the identity of the sub-network area (SNA_ID) to which the terminal is connecting. The SNA_ID identifying the subnetwork area may be broadcasted. Because each
5 subnetwork includes several subnetwork areas (SNAs), the SNA_IDs corresponding to a sub-network are each associated with the VoIPLR_ID of the VoIPLR in that sub-network. As noted above, there is one VoIPLR for each subnetwork.

In addition, there is a direct relation or correspondence between the SubscriberID and the VoIPLR_ID of the VoIPLR that homes the subscriber (the subscriber's Home VoIPLR). The
10 VoIPLR_ID identifies the Home VoIPLR of a subscriber. The Home VoIPLR_ID can be derived from a subscriber's SubscriberID. In this way, from the SubscriberID it is possible to identify the VoIPLR that is home to the subscriber (the subscriber's Home VoIPLR). The VoIPLR_ID of the Home VoIPLR can be derived (or obtained) from the SubscriberID in several different ways. For example, a look-up table can be used to identify a Home VoIPLR_ID corresponding
15 to each SubscriberID (because there is only one Home VoIPLR per subscriber). Alternatively, the VoIPLR_ID itself can be embedded or provided within the SubscriberID (e.g., provided as a portion of the SubscriberID), such as a suffix or prefix in the SubscriberID.

The VoIPLR is a database that contains the location information needed to locate the subscriber and deliver the services. The location information is an address (e.g., network address
20 or IP address of the subscriber) towards which calls have to be forwarded to reach the subscriber terminal.

Each VoIPLR can contain two types of records or profiles:

* Complete subscriber profile. The VoIPLR stores a complete subscriber profile if the VoIPLR is the Home VoIPLR for the subscriber. The complete subscriber profile for the subscriber may include the subscriber's name, SubscriberID, aliases (e.g., DN and Logical Name), subscriber service and the subscriber's current status (e.g., connected or not connected) and location (i.e., IP address at which the subscriber can be reached and an identification of the MVoIP network, subnetwork or area where the subscriber is located, and other location information such as a VLR number where subscriber is registered if subscriber has roamed to a cellular network).

* Roaming subscriber profile. A Roaming subscriber profile is stored in the current or serving VoIPLR (corresponding to the subnetwork where the subscriber is currently connected or located) if the current VoIPLR is different from the subscriber's Home VoIPLR. In other words, the subscriber is roaming if he/she is located in a subnetwork outside the subnetwork corresponding to his Home VoIPLR (including if the subscriber is now located in the cellular network).

For subscribers roaming to a different subnetwork, the Roaming subscriber profile could be all or a subset of the Complete subscriber profile which may be downloaded into the serving VoIPLR from the subscriber's Home VoIPLR upon request from the serving VoIPLR.

If the subscriber is connected to an MVoIP network (serving or home), the location information contained in the current VoIPLR record includes an IP address where a mobile terminated IP telephony call can be routed in the MVoIP network to reach the subscriber terminal. If the subscriber is not connected, the location information can be either void or could be a default IP address (e.g. answering machine).

The VoIPLR is also used also for subscribers roaming from a cellular network to a MVoIP network, and it keeps a record containing the service profile (or subscriber profile) and the location information for the subscriber. For subscribers roaming from a cellular network (i.e. homed in the cellular network), the service profile in the serving VoIPLR may be downloaded
5 as a subset of the subscriber's profile stored in the subscriber's HLR in the cellular network. When a subscriber homed in the MVoIP network roams to a cellular network, the subscriber's Home VoIPLR will be updated to store the address or identification of the cellular network VLR (e.g., a VLR number) where the user is temporarily registered, and other location information.

Also, each cellular network subscriber is homed by a HLR in the cellular network. The
10 HLR stores a complete subscriber profile for the cellular subscriber and maintains updated location information for the cellular subscriber.

The Cellular Gateway (CGW)

The Cellular Gateway (CGW) operates as an interface between the MVoIP network and the cellular network. The CGW provides two main functions:

15 1) interworking between the signaling procedures in the MVoIP network and cellular signaling to/from the cellular MSC/VLR in order to support roaming between the two networks;
and

2) it converts between circuit switched voice and packet switched voice for forwarded mobile terminated calls.

20 Regarding the interworking, as seen by the MVoIP network, the CGW behaves as:

a) a VoIPLR when a cellular subscriber (i.e., a subscriber homed by a cellular HLR) roams from the cellular network to the MVoIP network and the cellular subscriber's profile must be retrieved by the serving VoIPLR from the HLR via the CGW;

b) a VoIPLR when a MVoIP network subscriber (e.g., a subscriber homed by a Home VoIPLR) roams from the MVoIP network to the cellular network and the old registration (in the old VoIPLR) has to be deleted or canceled;

whereas, seen from the cellular network, the CGW behaves as:

a) a cellular HLR when a MVoIP network subscriber roams from the MVoIP network to the cellular network and the subscriber's profile must be retrieved from the subscriber's home VoIPLR;

b) a cellular VLR when a cellular subscriber roams from the cellular network to the MVoIP network and the old profile (in the old VLR) must be deleted or canceled.

The Mobile IP-Telephony Gateway (MITGW)

The Mobile IP Telephony GW (MITGW) is an IP Telephony GW augmented with mobility support, as described herein. The MITGW translates the received directory number (DN) of a call to the VoIPLR_ID of the Home VoIPLR of the called subscriber. The MITGW may then communicate with the Home VoIPLR to obtain the current location and status of the called subscriber (the subscriber corresponding to the DN). The MITGW may then establish the IP telephony call over the packet-switched network (e.g., Internet) between the MITGW and the current IP address where the called subscriber may be reached. As noted below, if the MVoIP subscriber has roamed to the cellular network, the CGW address is the address where the subscriber can be reached. As an example, the data packets of the IP-telephony call can be

provided between directly between the MITGW and the IP address where the called subscriber can be reached, while the signaling can be routed through the gatekeeper.

A registration procedure described below is used to constantly maintain updated status and location information of the subscriber terminal at the subscriber's Home VoIPLR (for
5 MVoIP network subscriber's), or the subscriber's Home HLR (for cellular network subscribers).

The subscriber status can include, for example, whether the subscriber terminal is connected or not connected to the network. A subscriber can also select other status options, such as blocking all incoming calls, while allowing the subscriber to place outgoing IP telephony calls. If a call is received that is intended for a subscriber that is either not connected to the
10 network or has blocked all incoming calls, the receiving MITGW (after obtaining the called subscriber's status and location from the called subscriber's Home VoIPLR), can either decline to place the requested call (e.g., return a busy or unavailable indication to the caller because the called party is not connected or incoming calls are blocked) or route the call to a predetermined IP address associated with the subscriber, such as the subscriber's answering machine or voice
15 mail system.

Each MITGW is able to derive or determine the VoIPLR_ID of the subscriber's Home VoIPLR based on a received directory number (DN) or other alias. For example, the VoIPLR_ID can be identified based on the DN using a look-up table. Because the Home VoIPLR contains the current location and status of the called subscriber, the MITGW can obtain the current
20 location (including the IP address where the subscriber can be reached) of the called subscriber based on the Home VoIPLR_ID. According to an embodiment of the present invention, the VoIPLR_ID may actually be or include the IP address of the Home VoIPLR.

In the event that the MVoIP network subscriber has roamed to the cellular network, the subscriber's Home VoIPLR will be updated (through the registration procedure described below) to store the updated location information for the subscriber, including the IP address of a Cellular Gateway (CGW) where the subscriber can be reached and the VLR number of the visiting location register in the cellular network where the subscriber is located.

In the event that a cellular network subscriber has roamed to a MVoIP network, the subscriber's Home location register (HLR) in the cellular network will be updated (as described below) to receive and store updated location information for the subscriber, including a pseudo-VLR number corresponding to the CGW where the subscriber can be reached in the cellular network (e.g., through Global Title Translation).

Registration For A MVoIP Subscriber Roaming to A Cellular Network

When a subscriber belonging to a mobile voice IP (MVoIP) network roams to a cellular network, it registers with the MSC/VLR in the serving cellular network. At this point the MSC/VLR initiates a procedure for updating the status and location information in the subscriber's HLR, de-registering the user from the previous VLR and downloading a roaming profile from the subscriber's HLR. In this case, the previous VLR is the "old" VoIPLR in the MVoIP network where the subscriber was previously registered, and the subscriber's HLR is the "home" VoIPLR in the MVoIP network that homes the subscriber. This process is described in greater detail with respect to Fig. 3.

Fig. 3 is a flow chart illustrating a registration procedure for a subscriber roaming to a cellular network according to an embodiment of the present invention. At block 305, the subscriber obtains an identification of the subscriber's location in the cellular network. A

different cellular subnetwork identification (a different cellular SN_ID) may be broadcast in each cellular subnetwork. The subscriber terminal can detect or obtain the cellular SN_ID from a broadcast channel, for example. The subscriber terminal may or may not register depending on whether the subscriber terminal is located in a new cellular subnetwork or has roamed from the MVoIP network to the cellular network. The subscriber terminal can compare its current network identification (the cellular SN_ID) to the previous network identification (the old SNA_ID identifying the subnetwork area of the MVoIP network where previously located) and because these do not match, the subscriber terminal determines that it is located in a new network or subnetwork. Because the subscriber has moved to a new network or subnetwork, the subscriber terminal should register with the registration entity serving the new network or subnetwork (i.e., the MSC/VLR corresponding to the SN_ID) to ensure that its home VoIPLR will receive updated location information (so that IP-telephony calls can be properly routed to the subscriber terminal). The remainder of the description in Fig. 3 assumes that the subscriber terminal will perform registration.

At step 310, the MVoIP subscriber terminal contacts the registration entity corresponding to the cellular SN_ID (i.e., the MSC/VLR serving the cellular subnetwork where the subscriber is located). The subscriber terminal provides its subscriberID and the old SNA_ID to the serving VLR. At block 315, the serving MSC/VLR issues a message to contact the subscriber's Home register (the subscriber's Home VoIPLR, which corresponds to the subscriberID) via the CGW. The message can include the subscriberID, the VLR number where the subscriber is registered, and possibly the old network identification (i.e., the old SNA_ID indicating where the subscriber was previously registered or located). The serving MSC/VLR sends this message using a cellular

network procedure (i.e., as a cellular network message). This cellular network message is routed to the CGW based on the subscriberID using Global Title Translation (i.e., the subscriberID is translated to the address of the CGW using GTT) or other technique. The CGW translates the cellular network message to a corresponding MVoIP network message, which is routed based on the subscriberID using Global Title Translation or other technique to the subscriber's Home VoIPLR.

At block 320, the subscriber's Home VoIPLR receives and stores, in the subscriber's profile, the VLR number (or the identification of the VLR) where the subscriber terminal is registered, the IP address where the subscriber can be reached over the MVoIP network and the SN_ID identifying the cellular subnetwork where the subscriber is located. The IP address where the subscriber can be reached corresponds to the IP address of the CGW.

Because the serving MSC/VLR contacted the subscriber's Home VoIPLR through the CGW, the packet or message received by the Home VoIPLR may have a source address identifying the IP address of the CGW. The format or type of the source address (the CGW's IP address) may inform the home VoIPLR that the packet came from a CGW, thus indicating that the subscriber terminal is connected to a cellular network. The packet or message received by the home VoIPLR may alternatively have a field or flag that explicitly specifies that the source address of the packet is a CGW (thus explicitly indicating the subscriber has roamed to a cellular network). Thus, at step 320, the home VoIPLR stores location information including the VLR number where the subscriber is registered and the address of the CGW, which is the address where the subscriber terminal can be reached.

At block 325, the serving MSC/VLR receives and stores a roaming profile from the subscriber's home VoIPLR via the CGW. The roaming profile may be a subset of the complete profile stored at the home VoIPLR.

At step 330, the Home VoIPLR cancels the roaming profile in the old VoIPLR if the old
5 VoIPLR is not the home VoIPLR. The old VoIPLR_ID is stored in the home VoIPLR, or the subscriber can provide the old network identification (i.e., the old SNA_ID).

Call Delivery from PSTN To A MVoIP Network Subscriber That Has Roamed to A Cellular Network

10 Fig. 4 is a flow chart illustrating call delivery to a roaming MVoIP network subscriber from a PSTN according to an embodiment of the present invention. Fig. 5 is a diagram illustrating call delivery to a MVoIP network subscriber roaming to a cellular network for a call from a PSTN according to an embodiment of the present invention. It is assumed that the MVoIP subscriber has roamed to a cellular network and registered with the serving MSC/VLR, as shown
15 above in Fig. 3.

Referring to Figs. 4 and 5, when a caller outside the MVoIP network dials the subscriber's directory number (DN), block 405, a PSTN call is directed towards one of the Mobile IP Telephony gateways (MITGWs) of the home MVoIP network of the called subscriber, block 410. This is illustrated as step 1 in Fig. 5.

20 At block 415, the MITGW identifies the VoIPLR_ID (which identifies the Home VoIPLR of the subscriber) corresponding to the dialed DN. The MITGW can identify the VoIPLR_ID corresponding to the DN using a look-up table, Global Title Translation or other technique.

At block 420, The MITGW contacts the subscriber's Home VoIPLR (corresponding to the dialed DN) and provides the DN to the Home VoIPLR in order to have the dialed number

(DN) translated into an IP address to set-up an IP telephony call towards the location of the subscriber. This is illustrated as step 2 in Fig. 5.

At block 425, the Home VoIPLR contacts the CGW where the subscriber can be reached. The address of the CGW was obtained by the Home VoIPLR during registration. The Home
5 VoIPLR provides the subscriberID and the VLR number where the subscriber is registered (also obtained during registration) to the CGW, and requests routing information (i.e., the roaming number) for the subscriber. This corresponds to step 3 in Fig. 5.

At block 430, the CGW contacts the MSC/VLR where the subscriber terminal is registered and obtains the subscriber terminal's roaming number (RN) in the cellular network
10 (i.e., the RN which corresponds to the subscriberID). This corresponds to steps 4 and 5 in Fig. 5.

At block 435, the CGW provides the subscriber's roaming number to the subscriber's Home VoIPLR, which corresponds to step 6 in Fig. 5.

At block 440, the Home VoIPLR provides the IP address of the CGW (where the
15 subscriber terminal can be reached) and the subscriber's roaming number to the MITGW. This corresponds to step 7 in Fig. 5.

At block 445, the MITGW sets up an IP telephony call towards the address of the CGW, and provides the subscriber's roaming number as an alias. This corresponds to step 8 in Fig. 5.

At block 450, the CGW, acting as an IP-telephony gateway, forwards the call over the
20 PSTN towards the subscriber's roaming number. The call is routed over the PSTN based on the roaming number to the serving MSC/VLR in the cellular network. This corresponds to step 9 in Fig. 5. The serving MSC/VLR then forwards the call to the subscriber terminal.

Call Delivery To A MVoIP Network Subscriber That Has Roamed to A Cellular Network For Calls Originated Within The MVoIP Network

When the subscriber's directory number (DN) or other Alias is dialed, two situations are possible: 1) the calling party is registered in the MVoIP network with a control entity (e.g. the gatekeeper in the H.323 standard) that controls the provisioning of services and the routing of calls; or 2) there is no control entity. These two situations will be briefly discussed.

The calling subscriber contacts the control entity (e.g., the gatekeeper where it is registered) and requests an IP telephony call to a called subscriber corresponding to a DN. The DN is provided to the control entity. The control entity identifies the VoIPLR_ID corresponding to the DN (identifying the Home VoIPLR of the called subscriber). The control entity contacts the called subscriber's Home VoIPLR and obtains the destination IP address of the CGW where the subscriber can be reached and the subscriber's roaming number. The control entity (e.g., gatekeeper) obtains the CGW's address and subscriber's roaming number in the same manner that the MITGW obtains this information in Figs. 4 and 5. The control entity then sets up an IP-telephony call between the calling subscriber and the CGW where the called subscriber can be reached, providing the roaming number as an alias.

If the called subscriber's Home VoIPLR cannot be reached (either because the called party is not a MVoIP network subscriber or due to technical/roaming agreement problems), the call is routed as a call towards the PSTN (e.g., routed to the nearest MITGW for routing to the PSTN) using the dialed DN as destination. On the called side, this received call is managed as an incoming call from PSTN., described in Figs. 4 and 5.

If no control entity is available, the call is routed as a call towards PSTN using the dialed DN as destination. On the called side, this case is managed as an incoming call from PSTN, described in Figs. 4 and 5.

Registration For A Cellular Subscriber Roaming to A MVoIP Network

5 The registration procedure for a cellular subscriber roaming to a MVoIP network is similar (e.g., symmetric) to the registration procedure for a MVoIP subscriber roaming to a cellular network (described in Fig. 3).

 The cellular subscriber obtains an identification of the subscriber's location in the MVoIP network, such as the SNA_ID, which may be broadcast. The subscriber compares the
10 old network identification (the old SN_ID from the cellular network) to the current SNA_ID. Because these don't match, this indicates that the subscriber should register to update its status and location information stored in its HLR (where the cellular subscriber is homed in the cellular network).

 The subscriber terminal obtains or generates a new (current) IP address based on the
15 SNA_ID. The subscriber may generate or obtain an IP address in a variety of different ways. For example, the subscriber's new address may be obtained using Dynamic Host Configuration Protocol (DHCP).

 To register, the cellular subscriber terminal contacts the serving registration entity corresponding to the SNA_ID which serves the subnetwork or area where the subscriber is
20 located. In this case, the cellular subscriber contacts the VoIPLR serving the MVoIP subnetwork where the subscriber is located (i.e., the VoIPLR corresponding to the SNA_ID). The subscriber provides its IP address, SubscriberID, its current status (e.g., connected or not, able to receive

incoming calls or not) and old SN_ID (identifying cellular subnetwork where previously connected) to the serving VoIPLR. This information is then stored in the serving VoIPLR. For example, this information can be provided to the serving VoIPLR through a gatekeeper. The subscriber may alternatively provide this information directly to the serving VoIPLR.

5 The serving VoIPLR contacts the subscriber's home register, which in this case is the cellular subscriber's HLR (the HLR corresponding to the subscriberID), via the CGW. The CGW receives the subscriberID, SNA_ID and old SN_ID. The CGW assigns a pseudo VLR number corresponding to the serving VoIPLR (pseudo because the VoIPLR is actually not a VLR). The CGW then provides the subscriberID, the pseudo VLR number indicating where the
10 subscriber is registered, and the old SN_ID identifying where the cellular subscriber was previously registered to the subscriber's HLR. The pseudo VLR number corresponds directly to (i.e., identifies) the VoIPLR_ID of the serving VoIPLR where the cellular subscriber is registered, but is provided in the proper cellular format for VLR numbers. The serving VoIPLR may receive and store from the HLR a roaming profile of the subscriber. The subscriber's HLR
15 will cancel the old roaming profile in the cellular subnetwork (or other subnetwork) indicated by the old network identification (e.g., the old SN_ID).

Call Delivery from PSTN To A Cellular Network Subscriber That Has Roamed to A MVoIP Network

A set of procedures are used to deliver a call from the PSTN to a cellular subscriber that
20 has roamed to a MVoIP network that is somewhat similar to the procedures for delivering the call to a roaming MVoIP subscriber (shown in Figs. 4 and 5).

Fig. 6 is a diagram illustrating call delivery for a PSTN call to a cellular network subscriber that has roamed to a MVoIP network according to an embodiment of the present invention.

Referring to Fig. 6, when a caller outside the MVoIP network dials the subscriber's
5 directory number (DN), a PSTN call is directed towards one of the MSC/VLRs in the cellular network (based on the DN) (PSTN call, step 1, Fig. 6). The MSC/VLR then contacts the HLR corresponding to the DN to request routing information (i.e., a roaming number, RN) for the subscriber corresponding to the DN (Route Request, step 2, Fig. 6). The HLR identifies the VLR number where the subscriber is registered (obtained during registration).

10 At step 3 of Fig. 6, the HLR contacts the VLR corresponding to the stored VLR number and provides the SubscriberID (subscriberID is illustrated in Fig. 6 as mobile subscriberID or MS_ID), in order to request the routing information for the subscriber. In this case, the VLR number stored in the HLR is actually a pseudo-VLR number because it corresponds to the CGW where the cellular subscriber can be reached through cellular procedures. Thus, in step 3, the
15 HLR contacts the CGW corresponding to the pseudo-VLR number stored in the HLR to request the routing or forwarding information (i.e., RN) for routing a call to the subscriber, providing the subscriberID (Route Request, step 3, Fig. 6).

At step 4 of Fig. 6, the CGW translates the pseudo-VLR number to the VoIPLR_ID identifying the serving VoIPLR where the cellular subscriber has registered. The CGW stored
20 the VoIPLR_ID corresponding to the subscriberID and pseudo-VLR number during the registration procedure. The CGW then contacts the serving VOIPLR and provides the subscriberID (MS_ID) to request the address of the subscriber (Addr. Request, step 4, Fig. 6).

At step 5 of Fig. 6, the serving VoIPLR provides the CGW with the destination IP address corresponding to the location where the subscriber can be reached. This IP address can be, for example, either the actual address of the subscriber or the IP address of a control entity or a Gatekeeper where the subscriber can be reached through (Addr. Response, step 5, Fig. 6).

5 At step 6 of Fig. 6, the CGW allocates a Roaming Number and stores in a table its correspondence with the subscriber's subscriberID (MS_ID) and the subscriber's destination IP address. The CGW provides the RN assigned to the subscriber back to the HLR (Route resp., step 6, Fig. 6).

10 At step 7 of Fig. 6, the HLR provides the RN assigned to the subscriber to the MSC/VLR (Route resp., step 7, Fig. 6).

At step 8, the MSC/VLR forwards the call to the subscriber's roaming number (RN), thus reaching the CGW. In other words, the call is forwarded to the CGW based on the RN (PSTN call, step 8, Fig. 6).

15 At step 9, the CGW retrieves the destination IP address and subscriberID (MS_ID) corresponding to the RN. The CGW then forwards the call by setting up an IP-telephony call towards the destination IP address where the subscriber can be reached and using the subscriberID (MS_ID) as an alias (IP-telephony call setup from CGW to subscriber address, step 9, Fig. 6).

20 Several embodiments of the present invention are specifically illustrated and/or described herein. However, it will be appreciated that modifications and variations of the present invention are covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

WHAT IS CLAIMED IS:

1 1. A method of allowing a subscriber to roam between two types of networks including
2 a packet-switched telephony network and a cellular network, the method comprising:
3 a subscriber terminal having a home location register located in the first type of network
4 and roaming to a second type of network;
5 the subscriber terminal providing the subscriber's subscriberID to a serving location
6 register in the second type of network;
7 sending a message from the serving location register in the second type of network to the
8 subscriber's home location register in first type of network via a gateway based on the
9 subscriberID, the gateway interfacing the first and second types of networks;
10 the subscriber's home location register in the first type of network receiving the message,
11 the message including updated location information for the subscriber terminal.

1

2 2. The method of claim 1 and further comprising the steps of:
3 receiving a request to call the subscriber terminal at the first type of network;
4 obtaining the updated location information from the subscriber's home location register;
5 establishing the call to the subscriber located in the second type of network based on the
6 subscriber's updated location information.

1 3. A method of allowing a packet-switched telephony network subscriber to roam to a
2 cellular network comprising:

3 providing the subscriber's subscriberID from a terminal of a packet-switched telephony
4 network subscriber to a serving visiting location register in the cellular network where
5 the subscriber terminal is located, the visiting location register being identified by a
6 register number;
7 sending a message from the serving visiting location register to the subscriber's home
8 location register in the packet-switched telephony network via a cellular gateway based
9 on the subscriber's subscriberID, the cellular gateway interfacing the packet-switched
10 telephony network and the cellular network; and
11 receiving the message at the subscriber's home location register in the packet-switched
12 telephony network, the received message including the register number identifying the
13 visiting location register in the cellular network where the subscriber terminal is located
14 and an address of the cellular gateway.
15 storing at the subscriber's home location register in the packet-switched telephony
16 network the register number identifying the visiting location register in the cellular
17 network and the address of the cellular gateway.

1 4. The method of claim 3 wherein the message sent from the serving visiting location
2 register includes the register number, and the address of the cellular gateway being added
3 to the message as the message passes through the gateway.

1 5. The method of claim 3 and further comprising the step of the serving visiting location
2 register in the cellular network receiving and storing a roaming subscriber profile via the

3 gateway from the subscriber's home location register in the packet-switched telephony
4 network.

1 6. The method of claim 3 and further comprising the step of the serving visiting location
2 register in the cellular network canceling a roaming profile in an old location register.

1 7. The method of claim 3 wherein said serving visiting location register in the cellular
2 network assigns a roaming number to the subscriber terminal.

1 8. A method of claim 3 and further comprising the steps of:
2 receiving a request for a call to the subscriber and an alias corresponding to the
3 subscriber;
4 obtaining the address of the cellular gateway and the roaming number assigned to the
5 subscriber terminal from the serving visiting location register via the cellular gateway;
6 establishing a packet-switched telephony call to the cellular gateway and providing the
7 subscriber's roaming number
8 establishing a PSTN call from the cellular gateway to the serving visiting location register
9 where the subscriber terminal is located, providing the subscriber's roaming number; and
10 establishing a cellular call from the serving visiting location register to the subscriber
11 terminal based on the subscriber's roaming number.

1 9. A method of allowing a packet-switched telephony network subscriber to roam to a
2 cellular network comprising:
3 receiving a call request to a subscriber terminal at a packet-switched telephony gateway,
4 including an alias of the subscriber;
5 obtaining, based on the alias, location information identifying the subscriber terminal's
6 location from a home location register of the subscriber in the packet-switched telephony
7 network, the subscriber's location information including an address of a cellular gateway
8 where the subscriber can be reached in the packet-switched telephony network and a VLR
9 number identifying a visiting location register where the subscriber is located in the
10 cellular network;
11 obtaining a roaming number that is assigned to the subscriber terminal;
12 establishing a packet-switched telephony call between the packet-switched telephony
13 gateway and the cellular gateway;
14 routing the call from the cellular gateway to the subscriber terminal based on the
15 subscriber's roaming number.

1 10. A method of allowing a packet-switched telephony network subscriber to roam to a
2 cellular network comprising:
3 a packet-switched network subscriber providing its subscriberID to a serving visiting
4 location register where the subscriber terminal is located, the serving visiting location
5 register being identified by a VLR number;

6 the subscriber's home location register in the packet-switched telephony network
7 obtaining the subscriber's location information from the serving visiting location register
8 via a cellular gateway, the cellular gateway interfacing the packet-switched telephony
9 network and the cellular network, the subscriber's location information including the
10 VLR number where the subscriber terminal is located and an address of the cellular
11 gateway;
12 receiving a call request to the subscriber at a packet-switched telephony gateway,
13 including an alias of the subscriber;
14 obtaining the subscriber's location information from the subscriber's home location
15 register based on the alias;
16 obtaining a roaming number that is assigned to the subscriber terminal;
17 establishing a packet-switched telephony call between the packet-switched telephony
18 gateway and the cellular gateway;
19 establishing a PSTN call from the cellular gateway to the serving visiting location register
20 and providing the subscriber's roaming number; and
21 establishing a cellular call from to the subscriber terminal.

1 11. A communication system allowing a subscriber to roam between two types of
2 networks including a packet-switched telephony network and a cellular network, the
3 system comprising:
4 a first type of a network including a home location register for a subscriber, the home
5 location register storing a subscriber profile including location information for the

6 subscriber for use in setting up calls to the subscriber regardless where the subscriber is
7 located;
8 a second type of network including a service location register servicing the second type
9 of network, the service location register receiving a subscriberID from the subscriber
10 when the subscriber has roamed to the second type of network;
11 a gateway coupled to the first type of network and the second type of networks and
12 interfacing the first and second types of networks, updated location information of the
13 subscriber being provided from the service location register to the subscriber's home
14 location register via the gateway.

1 12. The communication system of claim 11 wherein:
2 said first type of network comprises a packet-switched telephony network and the
3 subscriber is a packet switched telephony network subscriber;
4 said second type of network comprising a cellular network;
5 the home location register in the first type of network receiving a message from the
6 service location register via the gateway, the received message including the subscriber's
7 subscriberID, a register number identifying the service location register and an address
8 of the gateway.

1 13. The communication system of claim 11 wherein the first type of network further
2 comprises a serving location register servicing the first type of network.

1 14. The communication system of claim 11 wherein the second type of network further
2 comprises a home location register storing a subscriber profile for a subscriber of the
3 second type of network including location information for the subscriber.

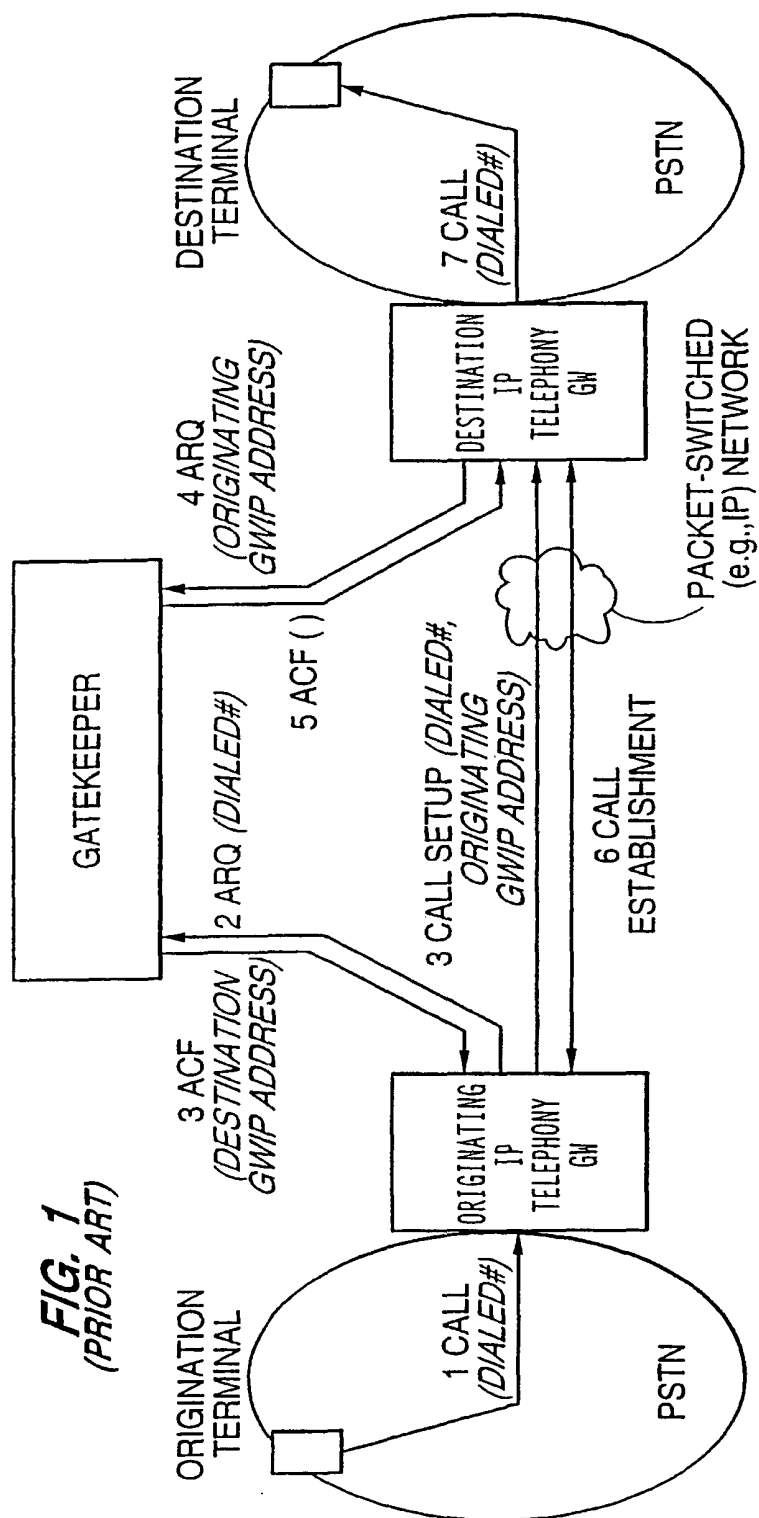
1 15. A communication system allowing a subscriber to roam between two types of
2 networks including a packet-switched telephony network and a cellular network, the
3 system comprising:
4 a first type of a network including a home location register for a subscriber, the home
5 location register storing a subscriber profile including location information for the
6 subscriber for use in setting up calls to the subscriber regardless where the subscriber is
7 located;
8 a second type of network including a service location register servicing the second type
9 of network, the service location register receiving a subscriberID from the subscriber
10 when the subscriber has roamed to the second type of network;
11 a cellular gateway coupled to the first type of network and the second type of networks
12 and interfacing the first and second types of networks, updated location information of
13 the subscriber being provided from the service location register to the subscriber's home
14 location register via the gateway;
15 a public switched telephone network;
16 a packet-switched telephony gateway coupled to the public switched telephone network
17 and at least one of the other types of networks for interfacing the public switched
18 telephone network and the other coupled network.

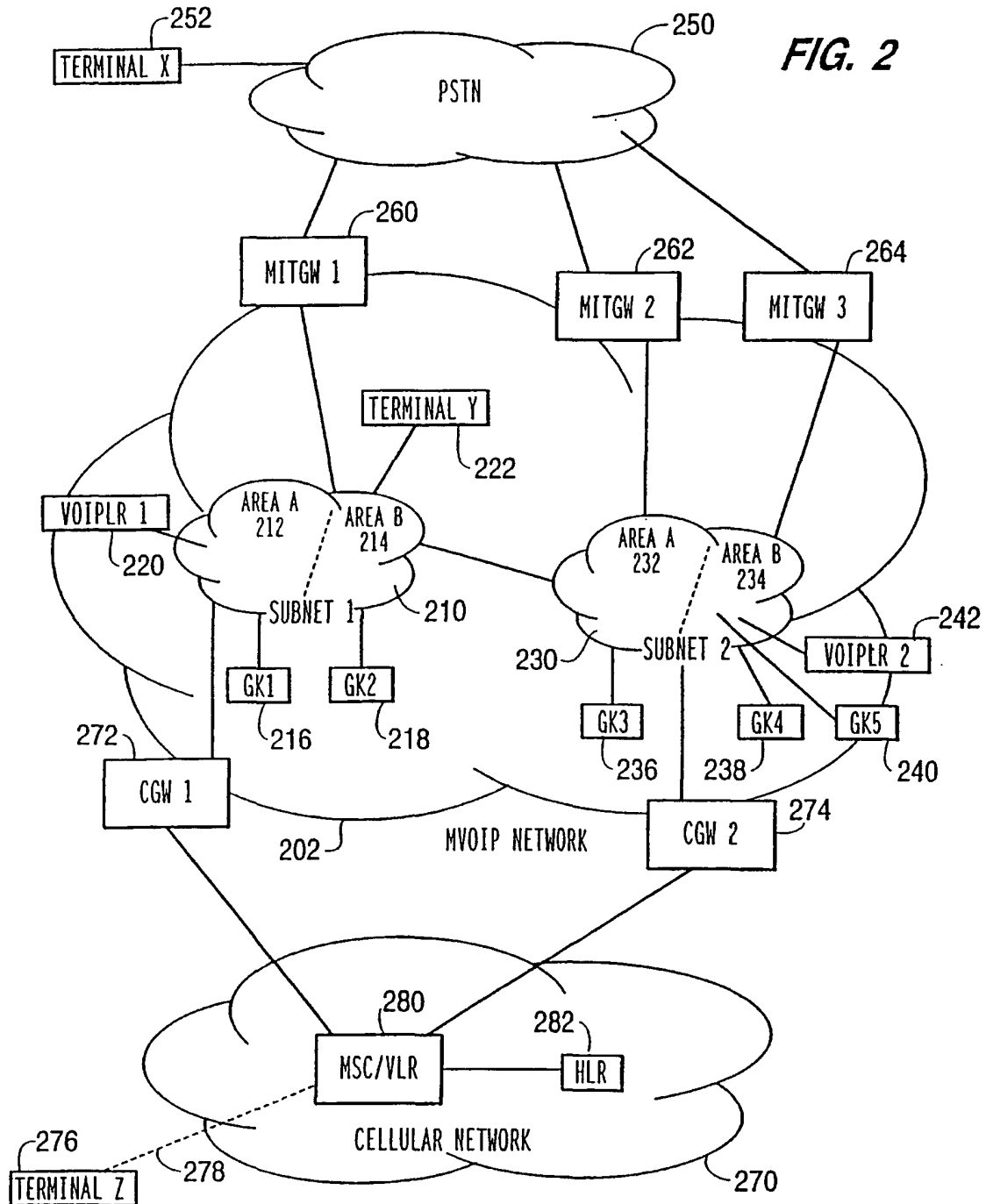
1 16. A method of allowing a cellular network subscriber to roam to a packet-switched
2 telephony network comprising:
3 providing the subscriber's subscriberID from a terminal of a packet-switched telephony
4 network subscriber to a serving location register in the packet-switched telephony
5 network where the subscriber terminal is located, the serving location register being
6 identified by a location register number;
7 storing in the serving location register an address where the subscriber can be reached;
8 sending a message from the serving location register to the subscriber's home location
9 register in the cellular network via a cellular gateway based on the subscriber's
10 subscriberID, the cellular gateway interfacing the packet-switched telephony network and
11 the cellular network; and
12 receiving the message at the subscriber's home location register in the cellular network,
13 the received message including the location register number identifying the serving
14 location register in the packet-switched telephony network where the subscriber terminal
15 is located and an address of the cellular gateway.
16 storing at the subscriber's home location register the location register number identifying
17 the serving location register in the packet-switched telephony network and the address
18 of the cellular gateway.

1 17. The method of claim 16 and further comprising the step of the cellular gateway

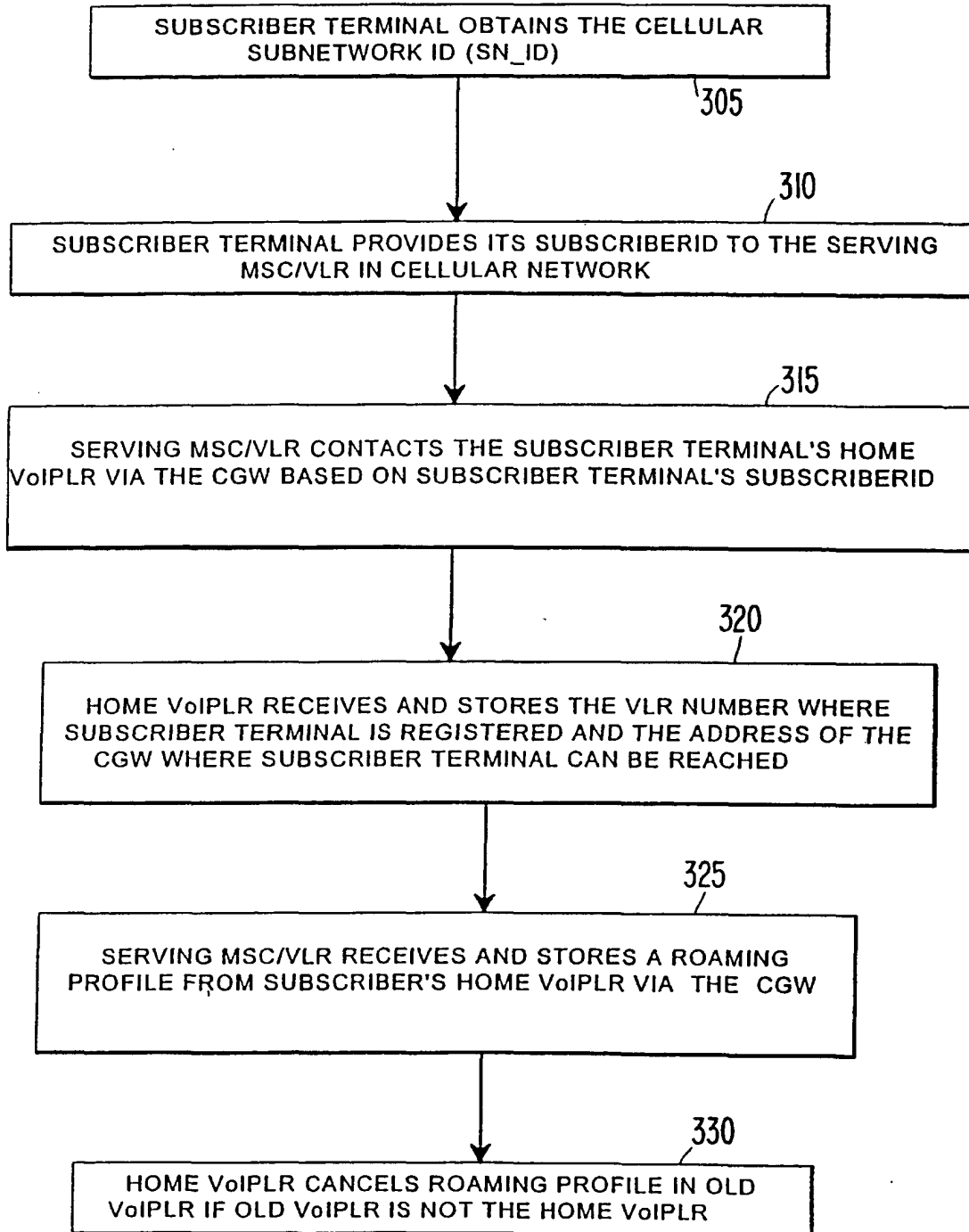
2 assigning a pseudo-register number for the cellular network as corresponding to the
3 location register number of the serving location register in the packet-switched telephony
4 network; and
5 said step of receiving comprising the step of receiving the message at the subscriber's
6 home location register in the cellular network, the received message including the
7 pseudo- register number corresponding to the serving location register in the packet-
8 switched telephony network where the subscriber terminal is located and an address of
9 the cellular gateway.

1 18. A method of claim 16 and further comprising the steps of:
2 receiving a request for a call to the subscriber and an alias corresponding to the
3 subscriber;
4 obtaining from the subscriber's home location register the location register number
5 identifying the serving location register in the packet-switched telephony network where
6 the subscriber terminal is located and an address of the cellular gateway;
7 obtaining, from the serving location register via the cellular gateway, the address where
8 the subscriber can be reached;
9 the cellular gateway assigning a roaming number to the subscriber;
10 obtaining the roaming number assigned to the subscriber from the cellular gateway;
11 routing the call to the cellular gateway based on the roaming number; and
12 establishing a packet-switched telephony call from the cellular gateway towards the
13 address where the subscriber can be reached.





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FIG. 3

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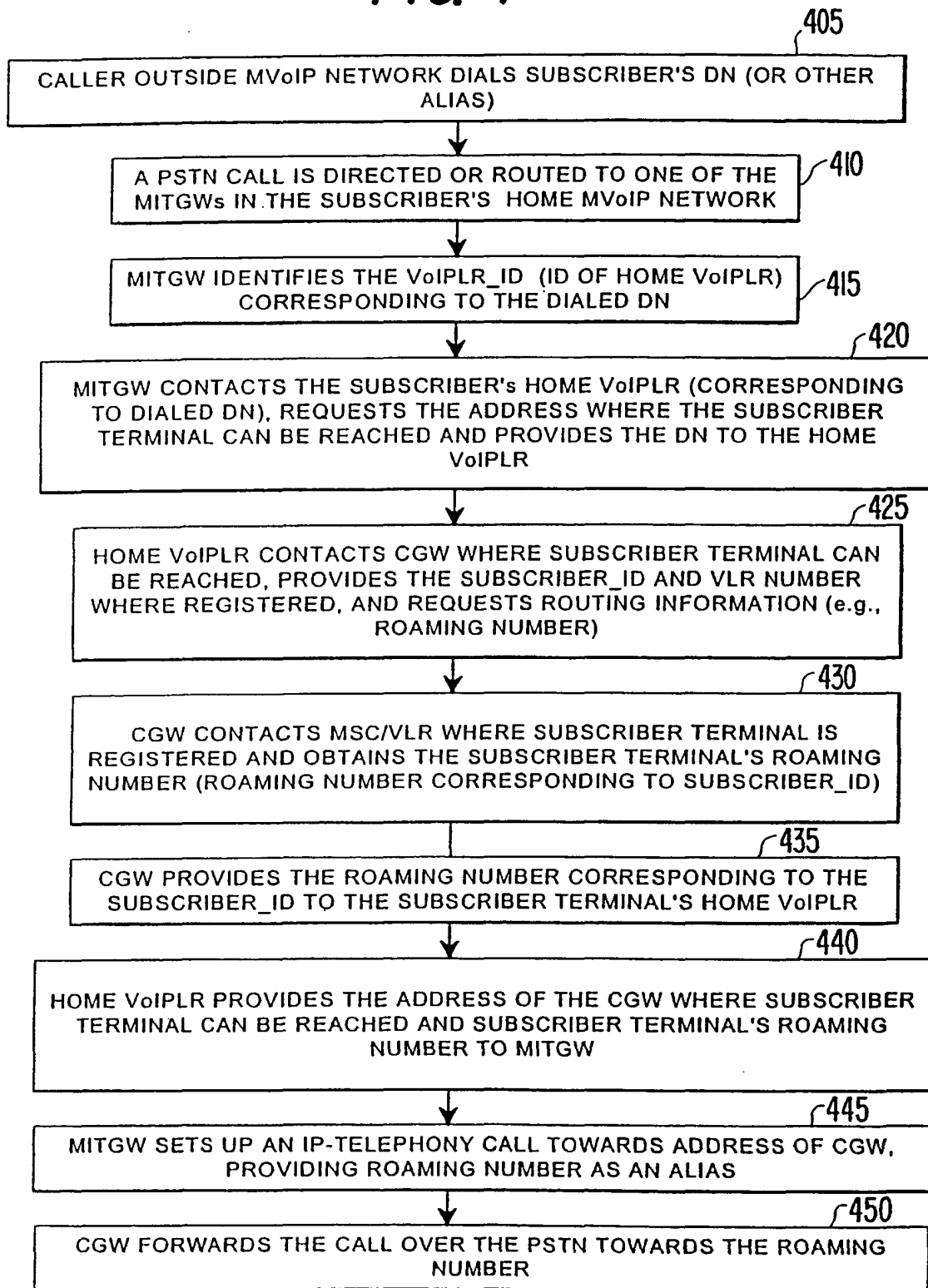
FIG. 4

FIG. 5

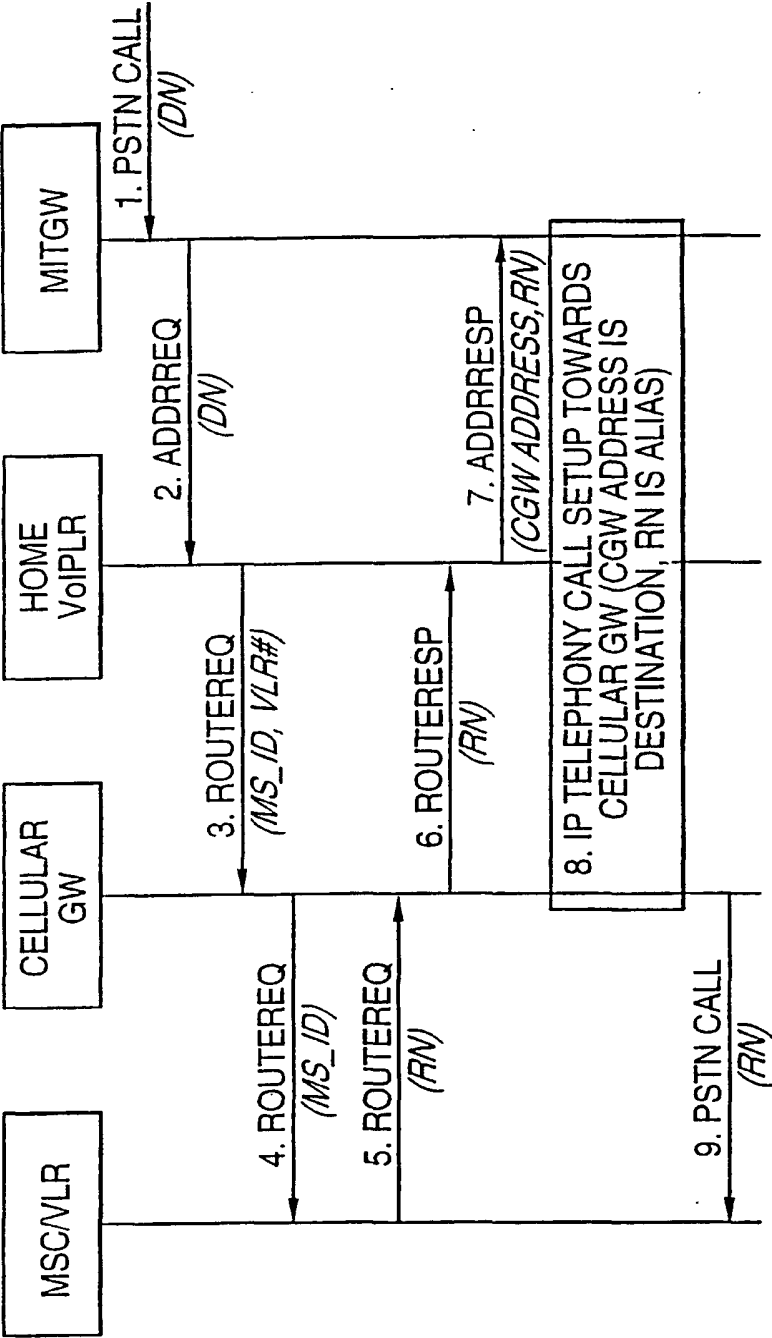
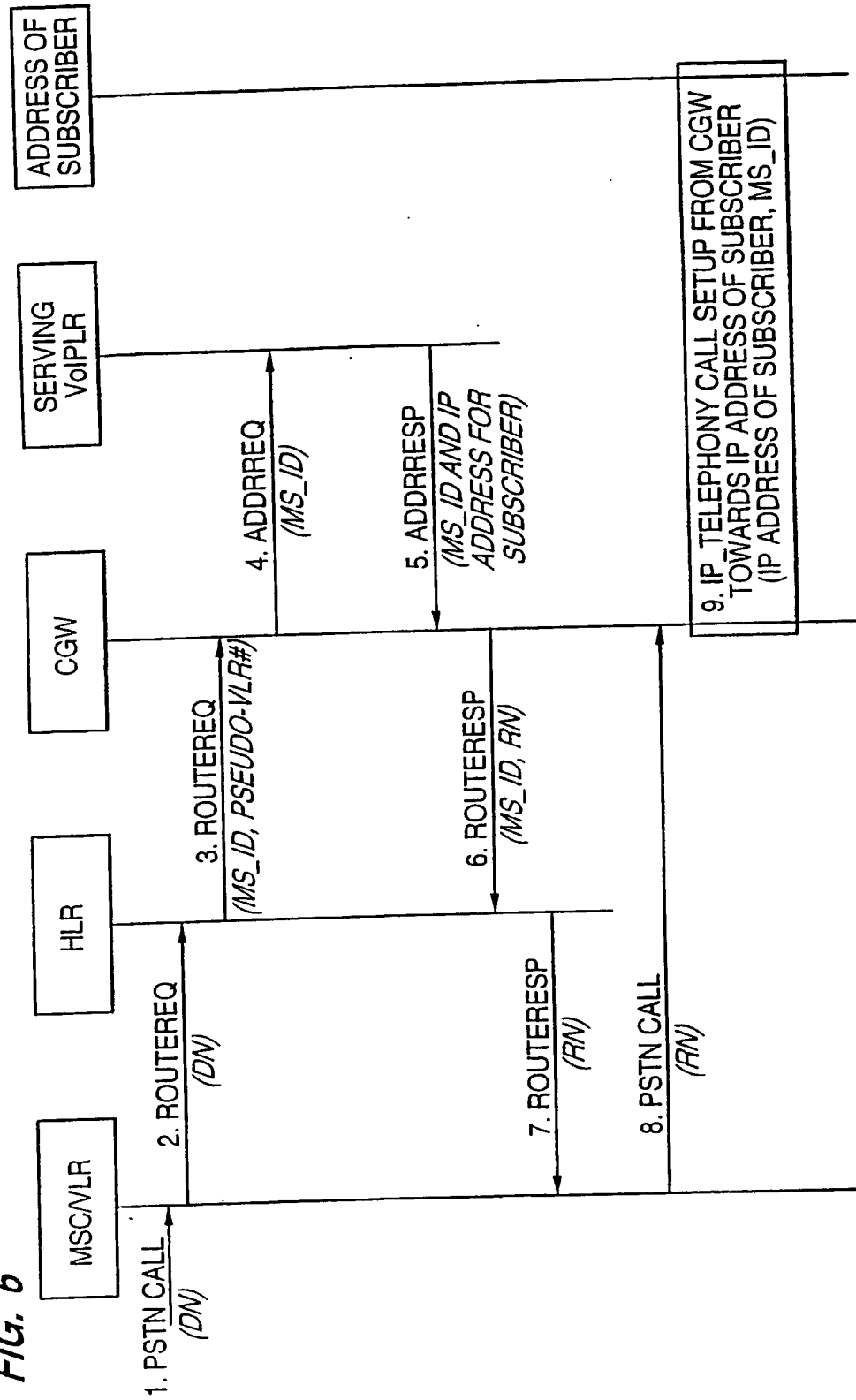


FIG. 6



INTERNATIONAL SEARCH REPORT

Inter. Appl. No.
PCT/US 00/13516

A. CLASSIFICATION OF SUBJECT MATTER IPC 7 H04Q7/22 H04Q7/38		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 7 H04Q		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	WO 98 43446 A (ERICSSON TELEFON AB L M) 1 October 1998 (1998-10-01) page 1, line 8 - line 10 page 6, line 4 - line 6 page 6, line 29 - line 31 page 7, line 3 - line 6 page 7, line 24 - line 29 page 13, line 1 - line 30; figure 5	1,11,14, 15 3,9,10, 12,13,16
A	WO 99 12329 A (DUTNALL STEPHEN ;BRITISH TELECOMM (GB)) 11 March 1999 (1999-03-11) page 16, line 30 -page 17, line 8 page 19, line 13 - line 15; figure 6	
P,A	WO 00 24212 A (ERICSSON INC) 27 April 2000 (2000-04-27) page 5, line 15 - line 20; figures 3A,3B	
<input type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex.		
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Date of the actual completion of the international search 16 August 2000		Date of mailing of the international search report 24/08/2000
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 00/13516

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9843446 A	01-10-1998	AU 6531598 A	20-10-1998
WO 9912329 A	11-03-1999	AU 8741498 A EP 1010314 A	22-03-1999 21-06-2000
WO 0024212 A	27-04-2000	AU 1318900 A	08-05-2000